

WHAT IS CLAIMED IS:

1 1. An oil pump comprising:

2 1) a plurality of pump chambers disposed substantially circumferentially and
3 rotatable in accordance with a rotation of a drive shaft, a pump chamber of the plurality of
4 the pump chambers defining a capacity which is substantially sequentially increased in a
5 first certain angle range and substantially sequentially decreased in a second certain angle
6 range, the pump chambers including;

7 a) a first pump chamber, and

8 b) a second pump chamber;

9 2) an intake port so formed as to be open in at least a part of an increase range
10 where the pump chamber moves from a minimum capacity position to a maximum
11 capacity position, the first pump chamber being free from being open to the intake port;

12 3) a discharge port so formed as to be open in at least a part of a decrease range
13 where the pump chamber moves from the maximum capacity position to the minimum
14 capacity position, in the decrease range the discharge port being biased to the minimum
15 capacity position's side, the second pump chamber being free from being open to the
16 discharge port;

17 4) a seal land portion disposed in a certain section between:

18 the maximum capacity position's side of the intake port, and

19 the maximum capacity position's side of the discharge port,

20 the seal land portion forming a stationary wall portion striding across the
21 plurality of the pump chambers, the seal land portion sealing a communication between
22 the intake port and the discharge port via the pump chamber;

23 5) a communication portion for allowing a mutual communication between the
24 first pump chamber and the second pump chamber of the plurality of the pump chambers
25 which face the seal land portion;

26 6) a reduced portion defined between the communication portion and the pump
27 chamber;

28 7) a bypass path connecting the communication portion with the discharge port;

29 and

30 8) a relief valve intervened in the bypass path and being adapted to open the
31 bypass path with a pressure of the communication portion increased to or over a set
32 pressure of the communication portion.

1 2. The oil pump as claimed in claim 1,
2 wherein

3 the relief valve includes:

4 1) a spool including;

5 a first end for introducing an oil of the communication portion, a
6 pressure of the thus introduced oil being applied to the first end of the spool, and

7 a second end to which a certain pressure that is lower than the pressure
8 of the discharge port is applied,

9 2) a spool receptacle for receiving therein the spool, and defining a
10 circumferential wall,

11 3) a biasing means for biasing the spool from the second end of the spool to
12 the first end of the spool, and

13 4) a drain port formed in the circumferential wall of the spool receptacle,
14 and communicating to the discharge port's side, and

15 wherein

16 in accordance with the pressure of the communication portion, the spool is
17 adapted to open and close the drain port.

1 3. The oil pump as claimed in claim 2, wherein

2 at a maximum speed of the drive shaft, a cavitation occurring in the pump chamber
3 causes a bubble, and

4 an angle range of the seal land portion is so set that the thus caused bubble is
5 smashed substantially completely on an eve of an opening of the pump chamber to the
6 discharge port.

1 4. The oil pump as claimed in claim 2,

2 wherein

3 the plurality of the pump chambers include:

4 1) a rotary element varying the capacity of the pump chamber in accordance with
5 the rotation of the drive shaft, and
6 2) a non-rotary element slidably contacting the rotary element, thereby
7 constituting a common wall portion of the plurality of the pump chambers, and
8 wherein
9 each of the intake port, the discharge port, and the communication portion is formed
10 into a slit which is disposed in an inner face of the non-rotary element, the inner face
11 facing the pump chamber's side.

1 5. The oil pump as claimed in claim 4, wherein
2 a circumferential width between the intake port and the communication portion and
3 a circumferential width between the communication portion and the discharge port are
4 substantially equal with each other, and
5 the circumferential width between the intake port and the communication portion is
6 substantially equal to a circumferential width of one of the pump chambers which crosses
7 therebetween, while the circumferential width between the communication portion and the
8 discharge port is substantially equal to a circumferential width of one of the pump
9 chambers which crosses therebetween.

1 6. The oil pump as claimed in claim 5, wherein
2 the oil pump is of a trochoid type having an outer tooth of an inner rotor and an
3 inner tooth of an outer rotor, the outer tooth and the inner tooth constituting a trochoid
4 curve.

1 7. An oil pump comprising:

2 1) a plurality of pump chambers disposed substantially circumferentially and
3 rotatable in accordance with a rotation of a drive shaft, a pump chamber of the plurality of
4 the pump chambers defining a capacity which is substantially sequentially increased in a
5 first certain angle range and substantially sequentially decreased in a second certain angle
6 range, the pump chambers including;
7 a) a first pump chamber, and
8 b) a second pump chamber;

- 9 2) an intake port so formed as to be open in at least a part of an increase range
10 where the pump chamber moves from a minimum capacity position to a maximum
11 capacity position, the first pump chamber being free from being open to the intake port;
12 3) a discharge port so formed as to be open in at least a part of a decrease range
13 where the pump chamber moves from the maximum capacity position to the minimum
14 capacity position, in the decrease range the discharge port being biased to the minimum
15 capacity position's side, the second pump chamber being free from being open to the
16 discharge port;
17 4) a seal land portion disposed in a certain section between:
18 the maximum capacity position's side of the intake port, and
19 the maximum capacity position's side of the discharge port,
20 the seal land portion forming a stationary wall portion striding across the
21 plurality of the pump chambers, the seal land portion sealing a communication between
22 the intake port and the discharge port via the pump chamber;
23 5) a communication portion for allowing a mutual communication between the
24 first pump chamber and the second pump chamber of the plurality of the pump chambers
25 which face the seal land portion;
26 6) a reduced portion defined between the communication portion and the pump
27 chamber;
28 7) a bypass path connecting the communication portion with the discharge port
29 (11); and
30 8) a relief valve intervened in the bypass path and being adapted to open the
31 bypass path with a pressure of the communication portion increased to or over a set
32 pressure of the communication portion, the relief valve having a valve-opening pressure
33 for opening the relief valve, the valve-opening pressure being set substantially equal to a
34 pressure of the discharge port.

- 1 8. The oil pump as claimed in claim 7,
2 wherein
3 the relief valve includes:
4 1) a spool including;

5 a first end for introducing an oil of the communication portion, a
 6 pressure of the thus introduced oil being applied to the first end of the spool, and
 7 a second end to which a certain pressure that is lower than the pressure
 8 of the discharge port is applied,
 9 2) a spool receptacle for receiving therein the spool, and defining a
 10 circumferential wall,
 11 3) a biasing means for biasing the spool from the second end of the spool to
 12 the first end of the spool, and
 13 4) a drain port formed in the circumferential wall of the spool receptacle,
 14 and communicating to the discharge port's side, and
 15 wherein
 16 in accordance with the pressure of the communication portion, the spool is
 17 adapted to open and close the drain port.

1 9. The oil pump as claimed in claim 8, wherein
 2 an atmospheric pressure is applied to the second end of the spool.

1 10. The oil pump as claimed in claim 9, wherein
 2 an adjustor gear is provided for externally adjusting the valve-opening pressure of
 3 the relief valve.

1 11. The oil pump as claimed in claim 10, wherein
 2 the adjustor gear adjusts an axial position of a holder for holding the biasing means
 3 which is a coil spring.

1 12. The oil pump as claimed in claim 11, wherein
 2 the adjustor gear is constituted of a screw mechanism that is capable of being turned
 3 externally.

1 13. The oil pump as claimed in claim 12,
 2 wherein
 3 the plurality of the pump chambers include:

4 1) a rotary element varying the capacity of the pump chamber in accordance with
5 the rotation of the drive shaft, and
6 2) a non-rotary element slidably contacting the rotary element, thereby
7 constituting a common wall portion of the plurality of the pump chambers, and
8 wherein
9 each of the intake port, the discharge port, and the communication portion is formed
10 into a slit which is disposed in an inner face of the non-rotary element, the inner face
11 facing pump chamber's side.

1 14. The oil pump as claimed in claim 13, wherein
2 a circumferential width between the intake port and the communication portion and
3 a circumferential width between the communication portion and the discharge port are
4 substantially equal with each other, and
5 the circumferential width between the intake port and the communication portion is
6 substantially equal to a circumferential width of one of the pump chambers which crosses
7 therebetween, while the circumferential width between the communication portion and the
8 discharge port is substantially equal to a circumferential width of one of the pump
9 chambers which crosses therebetween.

1 15. The oil pump as claimed in claim 14, wherein
2 the oil pump is of a trochoid type having an outer tooth of an inner rotor and an
3 inner tooth of an outer rotor, the outer tooth and the inner tooth constituting a trochoid
4 curve.

1 16. An oil pump comprising:
2 1) a plurality of pump chambers disposed substantially circumferentially and
3 rotatable in accordance with a rotation of a drive shaft, a pump chamber of the plurality of
4 the pump chambers defining a capacity which is substantially sequentially increased in a
5 first certain angle range and substantially sequentially decreased in a second certain angle
6 range, the pump chambers including;
7 a) a first pump chamber, and
8 b) a second pump chamber;

9 2) an intake port so formed as to be open in at least a part of an increase range
10 where the pump chamber moves from a minimum capacity position to a maximum
11 capacity position, the first pump chamber being free from being open to the intake port;

12 3) a discharge port so formed as to be open in at least a part of a decrease range
13 where the pump chamber moves from the maximum capacity position to the minimum
14 capacity position, in the decrease range the discharge port being biased to the minimum
15 capacity position's side, the second pump chamber being free from being open to the
16 discharge port;

17 4) a seal land portion disposed in a certain section between:
18 the maximum capacity position's side of the intake port, and
19 the maximum capacity position's side of the discharge port,
20 the seal land portion forming a stationary wall portion striding across the
21 plurality of the pump chambers, the seal land portion sealing a communication between
22 the intake port and the discharge port via the pump chamber;

23 5) a communication portion for allowing a mutual communication between the
24 first pump chamber and the second pump chamber of the plurality of the pump chambers
25 which face the seal land portion;

26 6) a reduced portion defined between the communication portion and the pump
27 chamber;

28 7) a bypass path connecting the communication portion with the discharge port
29 (11);

30 8) a relief valve intervened in the bypass path and being adapted to open the
31 bypass path with a pressure of the communication portion increased to or over a set
32 pressure of the communication portion; and

33 9) a narrowed portion fitted on an upstream side of the intake port, so as to cause
34 a cavitation in the pump chamber in accordance with a speed of the drive shaft, the
35 narrowed portion being so set as to form a deviation point in a graph showing the speed of
36 the drive shaft relative to a discharge flow rate.

1 17. The oil pump as claimed in claim 16, wherein

2 at a maximum speed of the drive shaft, the cavitation occurring in the pump
3 chamber causes a bubble, and

4 an angle range of the seal land portion is so set that the thus caused bubble is
5 smashed substantially completely on an eve of an opening of the pump chamber to the
6 discharge port.

1 18. The oil pump as claimed in claim 17,

2 wherein

3 the plurality of the pump chambers include:

4 1) a rotary element varying the capacity of the pump chamber in accordance with
5 the rotation of the drive shaft, and

6 2) a non-rotary element slidably contacting the rotary element, thereby
7 constituting a common wall portion of the plurality of the pump chambers, and

8 wherein

9 each of the intake port, the discharge port, and the communication portion is formed
10 into a slit which is disposed in an inner face of the non-rotary element, the inner face
11 facing the pump chamber's side.

1 19. The oil pump as claimed in claim 18, wherein

2 a circumferential width between the intake port and the communication portion and
3 a circumferential width between the communication portion and the discharge port are
4 substantially equal with each other, and

5 the circumferential width between the intake port and the communication portion is
6 substantially equal to a circumferential width of one of the pump chambers which crosses
7 therebetween, while the circumferential width between the communication portion and the
8 discharge port is substantially equal to a circumferential width of one of the pump
9 chambers which crosses therebetween.

1 20. The oil pump as claimed in claim 19, wherein

2 the oil pump is of a trochoid type having an outer tooth of an inner rotor and an
3 inner tooth of an outer rotor, the outer tooth and the inner tooth constituting a trochoid
4 curve.